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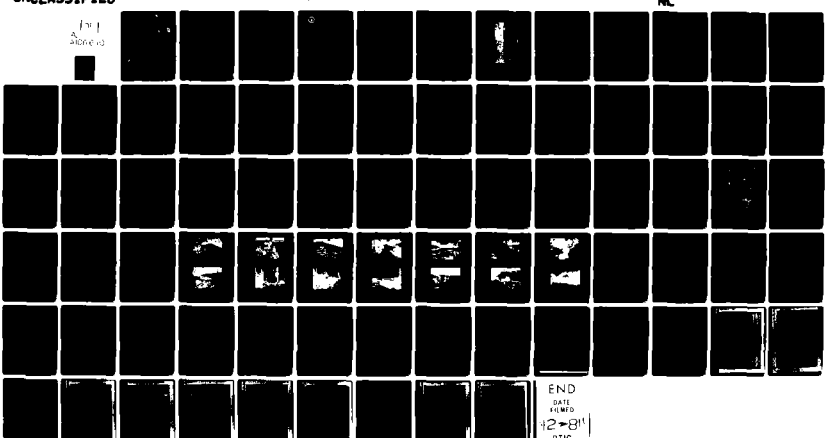

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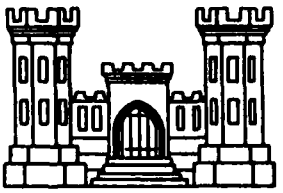
PERDIDO DAM

REYNOLDS COUNTY, MISSOURI

MO 31042

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JANUARY 1979

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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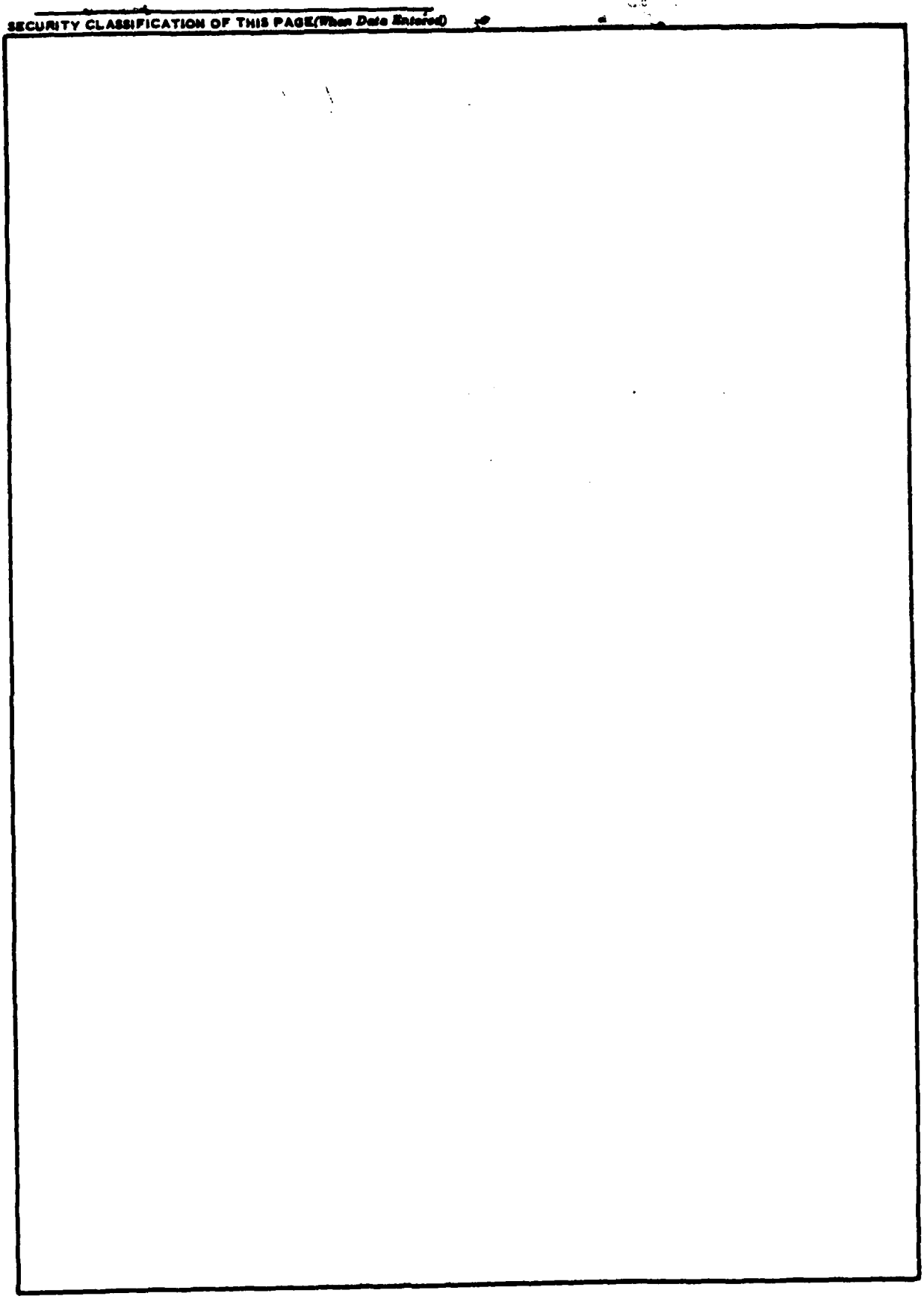


DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Perdido Dam (Mo. 31042), Phase I Inspection Report

This report presents the results of field inspection and evaluation of Perdido Dam (Mo. 31042).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood.

2) Overtopping could result in dam failure.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division
26 FEB 1979
(Date)

APPROVED BY: SIGNED
Colonel, CE, District Engineer
28 FEB 1979
(Date)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Perdido Dam, Missouri Inv. No. 31042
State Located:	Missouri
County Located:	Reynolds
Stream:	Unnamed Tributary of East Fork of Black River
Date of Inspection:	October 2, 1978

Assessment of General Condition

Perdido Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

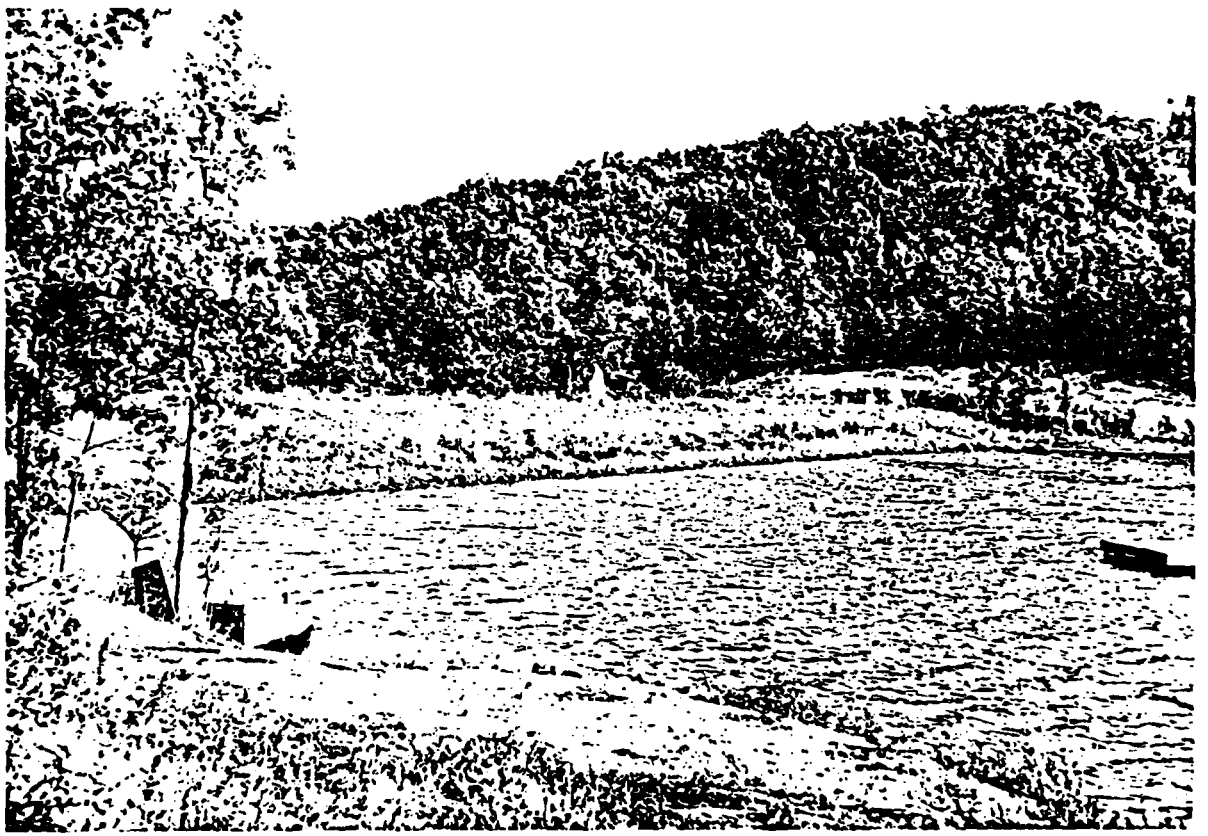
Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Five houses, two mobile homes, and one State Highway crossing would be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Perdido Dam is in the intermediate size classification since it is more than 40 feet, but less than 100 feet high, and impounds more than 1,000 acre-feet, but less than 50,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of Perdido Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Perido Dam is an intermediate size dam with a high hazard potential required by the guidelines to pass from one-half Probable Maximum Flood to the Probable Maximum Flood without overtopping. Since there are five houses downstream of the dam, the Probable Maximum Flood is the appropriate Spillway Design Flood (SDF). It was determined that the spillway will pass 19 percent of the Probable Maximum Flood without overtopping of the dam. Our evaluation indicates that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by the inspection team were a need for an annual inspection by a qualified professional engineer; lack of a maintenance schedule; a damaged concrete service spillway structure; and an unstable left bank of the emergency spillway channel. The lack of stability and seepage analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.



PERDIDO DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Perdido 1 Dam, I.D. No. 31042

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NATIONAL DAM SAFETY PROGRAM

PERDIDO DAM, Missouri Inv. No. 31042

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for the Perdido Dam was carried out under Contract DACW 43-78-C-0160 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associates Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of the Perdido Dam was made on October 2, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to west abutment or side, and right to the east abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of the Project

a. Description of Dam and Appurtenances

It should be noted that design drawings are not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam embankment is a rolled earthfill structure. The crest has a width of 30 feet, and a length of 407 feet. The crest elevation is set at 1,106.0 feet above MSL, and the maximum height of the embankment is 58 feet above the minimum streambed elevation along the centerline of the dam.

The upstream slope of the embankment section is constructed with a 1V to 3-3.5H slope. The slope is protected with a 2 to 3 foot thick layer of dumped riprap. The riprap was composed of hard, irregular blocks of granite to a maximum size of 2 feet in diameter, with most of the blocks 4 to 12 inches in diameter. The downstream embankment was constructed with a 1V to 3H slope, protected with a light vegetative cover.

Bedrock at the site and within the vicinity is composed of Pre-Cambrian age felsite and Cambrian age dolomite and sandstone. The rolling hills adjacent to the site are mantled by residual sands and clays, weathered products of the bedrock. Alluvial deposits are encountered along the stream course of the area.

The left abutment of the dam is founded in hard dolomite, while the right abutment and spillway are founded in felsite. Jointing is apparent in the felsite and the planes have attitudes of N15°W, 75°SW; N30°E, 84°SE; and N62°W, 90°. Exposures in the topographically lower portion of the spillway discharge channel indicate that a sandstone overlies the felsite; a soft clay lies between these two units, which suggests that they are possibly in fault contact. This clay may trend subparallel to one of the attitudes of the joints.

The service spillway is located in the embankment near the right abutment and consists of a concrete drop inlet box, 32 inches by 32 inches in plan, by 4 feet deep, on the upstream face of the embankment. This structure discharges into a 24-inch diameter corrugated metal pipe passing through the embankment. The pipe outlet discharges into a small ditch connecting to the emergency spillway channel. The drop inlet is covered by a light weight wire mesh screen mounted into a crude wooden frame.

A 24-inch diameter cast iron sluice gate is mounted on the upstream face of the drop inlet box with an invert 4 feet below the overflow inlet to the box. The position of the gate permits making downstream releases and drawing down the reservoir whenever the reservoir level is between the spillway crest and the gate invert.

The reservoir at Perdido Dam impounds approximately 1,150 acre-feet of water from a drainage area of 2.45 square miles.

b. Location

Perdido Dam is located on an unnamed tributary of the East Fork of the Black River, Reynolds County, Missouri, which is in the southeast quarter of the state. Perdido Lake can be reached by travelling south on Highway 21 from Graniteville, Missouri, for one mile, then south on Route N for 7 miles. The lake is approximatley 1/2 mile down the unmarked gravel road to the left. The nearest downstream community is Graniteville, which is approximately 6 miles northeast of the dam. The dam and reservoir are shown on the Johnson Shut-Ins Quandrangle Sheet (7.5 minute series) in Section 1, Township 33 North, Range 2 East.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Intermediate" since its storage is more than 1,000 acre-feet, but less than 50,000 acre-feet. The dam is also classified as "Intermediate" in dam size category because its height is more than 40 feet, but less than 100 feet. The overall size classification is, accordingly, "Intermediate" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends

eight miles downstream of the dam. Within the first two miles downstream of the dam are four to five houses, two mobile homes, associated outbuildings, and one State highway crossing.

e. Ownership

Perdido Dam is owned by a private owner, Mr. William F. Simon, 540 Country Club Lane, Coronada, California 92118.

f. Purpose of Dam

The main purpose of the dam is to impound water for recreational use as a private lake .

g. Design and Construction History

Perdido Dam was constructed in 1975 by Helton Construction Company of Eldon, Missouri. Mr. Helton was the engineer on the job, and no formal plans or specifications were made.

h. Normal Operational Procedures

The dam is used to impound water for recreational use only. The lake is privately owned and operated, and receives a limited amount of use. The water level is controlled by rainfall, runoff, and evaporation. The water level is also maintained by the uncontrolled service and emergency spillways, and can be controlled somewhat by the sluice gate. It is believed that the water level is kept close to full at all times. The inspection team is not aware of any operational or water level records which are kept for Perdido Dam.

Since the owner of the lake lives out of state, a local resident serves as the caretaker.

1.3 Pertinent Data

a. Drainage Area (square miles):	2.45
b. Discharge at Damsite	
Estimated experienced maximum flood (cfs):	500
Estimated ungated spillway capacity at maximum pool elevation (cfs):	1,500
c. Elevation (Feet above MSL)	
Top of dam:	1,106.0
Spillway crest:	
Service Spillway	1,100.0
Emergency Spillway	1,100.5
Minimum streambed elevation at centerline of dam:	1,048.0
Maximum tailwater:	Unknown
d. Reservoir	
Length of maximum pool:	4,000 feet
e. Storage (Acre-Feet)	
Top of dam:	1,523
f. Reservoir Surface (Acres)	
Top of dam:	72
Spillway crest:	58
g. Dam	
Type:	Rolled Earthfill
Length:	407 feet

Height (maximum):	58 feet
Top width:	30 feet
Side slopes:	
Downstream	1V to 3H
Upstream	1V to 3-3.5H
Zoning:	None
Impervious core:	The dam is reported to be constructed with core material of "Solid Native Clay"
Cutoff:	The dam is reported to have two cutoff trenches with base widths of 30 feet and side slopes of 1V to 3H
Grout curtain:	None

h. Diversion and Regulating Tunnel None

i. Spillway

Type:	
Service Spillway	Uncontrolled Drop Inlet
Emergency Spillway	Uncontrolled Open Channel
Length of weir:	
Service Spillway	10.68 feet
Emergency Spillway	35 feet
Crest Elevation (feet above MSL):	
Service Spillway	1,100
Emergency Spillway	1,100.5

j. Regulating Outlets

Type:	24-inch diameter corrugated metal pipe
Length:	75 feet
Closure:	24-inch diameter cast iron sluice gate
Maximum Capacity:	30 cfs

SECTION 2: ENGINEERING DATA

2.1 Design

Design drawings are not available for the dam and appurtenant structures. The dam was designed in 1975 by the owner of Helton Construction Company. Conversations with the owner indicate that the dam was constructed of native clay, compacted with a sheeps-foot roller. Two cores, with a base width of 30 feet and side slopes of 1V to 3H, were reportedly excavated to an unknown depth into the alluvium for cut-off.

2.2 Construction

The dam was constructed in 1975 by Helton Construction Company. No construction data is available for the dam or appurtenant structures.

2.3 Operation

No operation data is available for Perdido Dam.

2.4 Evaluation

a. Availability

No design drawings, design computations, construction data, or operation data is available.

In addition, no pertinent data was available for review of hydrology spillway capacity, flood routing through the reservoir, outlet capacity, slope stability, seepage analysis, or foundation conditions.

b. Adequacy

The available engineering data is inadequate to aid in evaluating the hydraulic and hydrologic capabilities and stability of the dam for Phase I investigations.

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgment.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data is available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of Perdido Dam was made on October 2, 1978. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

b. Dam

The crest of the dam appears to have been covered with the smaller gravel and sand-sized rock excavated from the spillway. This material is providing excellent protection for the crest.

The riprap on the upstream embankment slope is providing excellent protection for the embankment material. No degradation due to weathering of the blocks was observed. Some minor surface erosion is occurring on the downstream

embankment slope. The condition has progressed further at the abutment contacts, but is not serious at this time. A small scarp was observed along the contact of the embankment fill and the ground surface. The embankment material that could be obtained on the downstream slope appeared to be a clay with 20 to 40 percent sands and gravels. The material would be classified as CL by the Uniform Soil Classification System.

No signs of past or present instability was seen on the embankment or in the foundation at any location. Also, no seepage was observed on the downstream embankment slope or downstream of the toe of the dam.

c. Appurtenant Structures

(1) Spillway

The service spillway concrete intake structure has been damaged. The entire concrete structure was tilted due to ice over 24 inches thick in the lake in the winter of 1977. The 24-inch C.M.P. and the discharge channel are in adequate condition.

The emergency spillway is an open channel cut into rock. It is a well defined and clean channel. However, after the spring floods of 1977, the emergency spillway channel began to shift and erode into the west bank, which is constructed with dumped material. The most critical location is at approximately 150 feet downstream from the spillway crest. At this location, the left (west) bank of the spillway channel wall is less than 3 feet thick.

(2) Outlet Works

Observations were made of the drop inlet structure, the handwheel operator and its support for the sluice gate, and the downstream portal area of the 24-inch C.M.P.

The drop inlet structure has been tilted approximately 5^{o} from its initially constructed position. The structure is still serviceable, as evidenced by the fact that there was no leakage into the pipe, even though the water level was 3 feet above the pipe.

The sluice gate was submerged, but was seen to be closed, as indicated by the position of the operating stem relative to the handwheel. The extreme upper end of the stem (at the handwheel) was bent. There was no leakage past this gate.

The downstream section of the outlet pipe was in good condition, showing no signs of significant deterioration.

The concrete surface showed effects of poor consolidation during construction, but the overall condition of the visible concrete was adequate for a small structure.

d. Reservoir Area

At the time of inspection, the water level in the reservoir was 1.5 feet below the emergency spillway crest. No indication of instability or severe erosion along the reservoir rim was apparent. At present, no development has occurred along the shoreline. The slopes adjacent to the reservoir contain thick forest and woodland.

e. Downstream Channel

Flow at the service spillway enters into the intake box, then through a 24-inch C.M.P., and into an unlined trapezoidal channel which is partially cut in rock. This channel is oriented in a south to north direction, and is approximately 300 feet long before draining into the emergency spillway discharge channel. The emergency spillway discharge channel is a rock channel for most of the length, until it reaches the downstream bend where the channel is in an earth cut. Erosion and sloughing are evident in this reach of the channel. Discharges from the spillway would flow into the former streambed of the tributary creek, which is generally a heavily wooded valley.

3.2 Evaluation

The visual inspection did not exhibit any items which are sufficiently significant to indicate a need for immediate remedial action.

The following items were observed which could affect the safety of the dam, or which will require maintenance within a reasonable period of time.

1. The tilted service spillway intake structure.

2. The eroded left bank of the emergency spillway discharge channel.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Perdido Dam is used to impound water from rainfall and runoff for recreational use only. Normal procedure is to let the lake remain as close to full as possible. The owner presently lives out of state and the lake and dam are maintained by a local resident.

4.2 Maintenance of Dam

Because of the fact that the dam is just over 3 years old, its slopes and crest seem to be in good condition. Most of the problems observed at the damsite involve the spillway inlet structure, and the emergency spillway discharge channel. The west side (left bank) of the emergency spillway channel is badly eroded and generally unstable. The concrete intake structure for the service spillway is tilted approximately 5^{o} from its original position, and its stability is questionable.

4.3 Maintenance of Operating Facilities

The only facility at the damsite which requires operation is the 24-inch sluice gate which is located on the south side of the intake structure. The extreme upper end of the operating stem for the sluice gate was bent. At the top of the 32-inch square opening to the tower is a very light weight screen which should be replaced with a trashrack of heavier construction. There are no available maintenance of operating records for the dam and appurtenant structures.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect.

4.5 Evaluation

Generally speaking, the operation and maintenance at the damsite is adequate. To improve the operational adequacy of the dam, the corrective measures outlined in this report, concerning the emergency spillway erosion and the service intake, should be undertaken within a reasonable period of time.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

No hydrologic design data is available.

Perdido Lake has a watershed of approximately 1,560 acres. Land gradients in the watershed average roughly 25 percent. The lake is located on an unnamed tributary of the East Fork of the Black River.

Elevations within the watershed range from approximately 1,050 feet above MSL at the damsite to over 1,550 feet above MSL in the upper portion of the watershed.

The watershed is approximately 95 percent covered by forest and woodland, with the remainder being covered by grass and brush. A drainage map showing the watershed area is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of Perdido Dam was based on criteria set forth in the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometerological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in

EM 1110-2-1411 (Standard Project Storm). The SCS triangular hydrograph, transformed to a curvilinear hydrograph, was adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF are 21,151 cfs and 10,575 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 17,189 cfs and 7,280 cfs, respectively. Both the PMF and one-half of the PMF, when routed through the reservoir, resulted in overtopping of the dam.

The stage-outflow relation for the spillways were prepared from field notes and sketches. The reservoir stage-capacity data were based on the U.S.G.S. quadrangle topographic maps. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curves assumed that the dam remains intact during routing. The spillway rating curves and the reservoir capacity curve are also presented in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored waters suddenly into the downstream floodplain. The safe hydrologic design of a dam calls for a spillway discharge capability in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs its dams to safely pass the Probable Maximum Flood that is estimated could be generated from the upstream watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to interviews with the owner's representative, the maximum reservoir level was in April 1977, which was lower than the crest of the embankment.

c. Visual Observations

The intake box on the service spillway is tilted approximately 5^{o} from its original position. The emergency spillway discharge channel bed is in rock, and is in good condition, except that the left bank of the discharge channel which is badly eroded and shows signs of instability.

There is no drawdown facilities to evacuate the reservoir. The spillway and exit channel are located very close to the right abutment of the dam. If the unstable condition at the left bank of the emergency spillway channel is not corrected, future discharges will rapidly erode this bank and allow water to flow down the embankment slope.

d. Overtopping Potential

As indicated in Section 5.1-a., both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The PMF and one-half of the PMF overtopped the dam crest by 4.96 feet and 2.59 feet, respectively. The total duration of embankment overflow is 6.50 hours during the PMF, and 4.50 hours during one-half of the PMF. The spillway of the Perdido Dam is capable of passing a flood equal to approximately 19 percent of the PMF just before overtopping of the dam. The 19 percent PMF has a frequency occurrence approximately equal to a one percent chance flood.

The effect from rupture of the dam could extend approximately eight miles downstream of the dam. There are four to five farmhouses, two mobile homes and associated outbuildings, and one State highway crossing within the first two miles of the floodplain area.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no signs of settlement or distress observed on the embankment or foundation during the visual inspection. The upstream slope, crest, and downstream slope are well protected by either riprap or vegetation. Seepage was not observed on the downstream slope or beyond the toe of the embankment.

The left bank of the emergency spillway channel, approximately 150 feet downstream from the emergency spillway, is in an unstable condition. If this condition is not corrected, future discharges will rapidly erode this bank, allowing water to flow onto and erode the right side of the downstream slope of the dam.

b. Design and Construction Data

No design or construction data relating to the structural stability of the dam or appurtenant structures were found.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. Water levels have not been recorded, however, the reservoir was within 1 foot of being full on the day of inspection, and is assumed to be close to full at all times. The only operation facility at the dam is the sluice gate attached to the service spillway structure.

d. Post Construction Changes

No post construction changes exist which will affect the structural stability of the dam.

e. Seismic Stability

In general, projects located in Seismic Zones 0, 1 and 2 can be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. Perdido Dam is located in Seismic Zone 2. A detailed seismic analysis is not felt to be necessary for this embankment.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition could be detected.

a. Safety

The spillway was found to be capable of passing a flood equal to 19 percent of the PMF without overtopping the dam.

The physical condition of Perdido Dam is in generally satisfactory. The major problems with the dam and appurtenant structures involve the spillways. The service spillway structure should be repaired by resetting the con-

crete box inlet in a vertical position, and grouting around the structure to prevent future damage. A trashrack with bars should replace the existing wire mesh cover. The emergency spillway's left bank is in an unstable condition following recent discharges due to flooding. The spillway channel is sloped toward the left bank, causing flow through the spillway to concentrate in this area. It is predicted that future discharges through the spillway channel would rapidly breach the left bank, causing water to flow across the abutment and onto the downstream embankment.

b. Adequacy of Information

Information concerning the dam and appurtenant structures is not available. It is recommended that the following programs be initiated to help alleviate this problem:

1. Periodic inspection of the dam by an engineer experienced in the design and construction of earth dams.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. The dam should be surveyed and an as-built set of plans and drawings should be completed.

4. Perform seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished in the near future.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken as soon as possible, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

Possible alternatives for increasing the spillway capacity include:

1. Widening the spillway by excavating further into the right abutment.

2. Lowering the elevation of the spillway crest.

3. Raising the dam embankment.

4. Combination of the above.

b. Repair the concrete service spillway structure.

c. Reconstruct the emergency spillway channel to slope toward the right bank, and stabilize the eroded left bank.

d. O & M Maintenance Procedures

The owner should initiate the following programs:

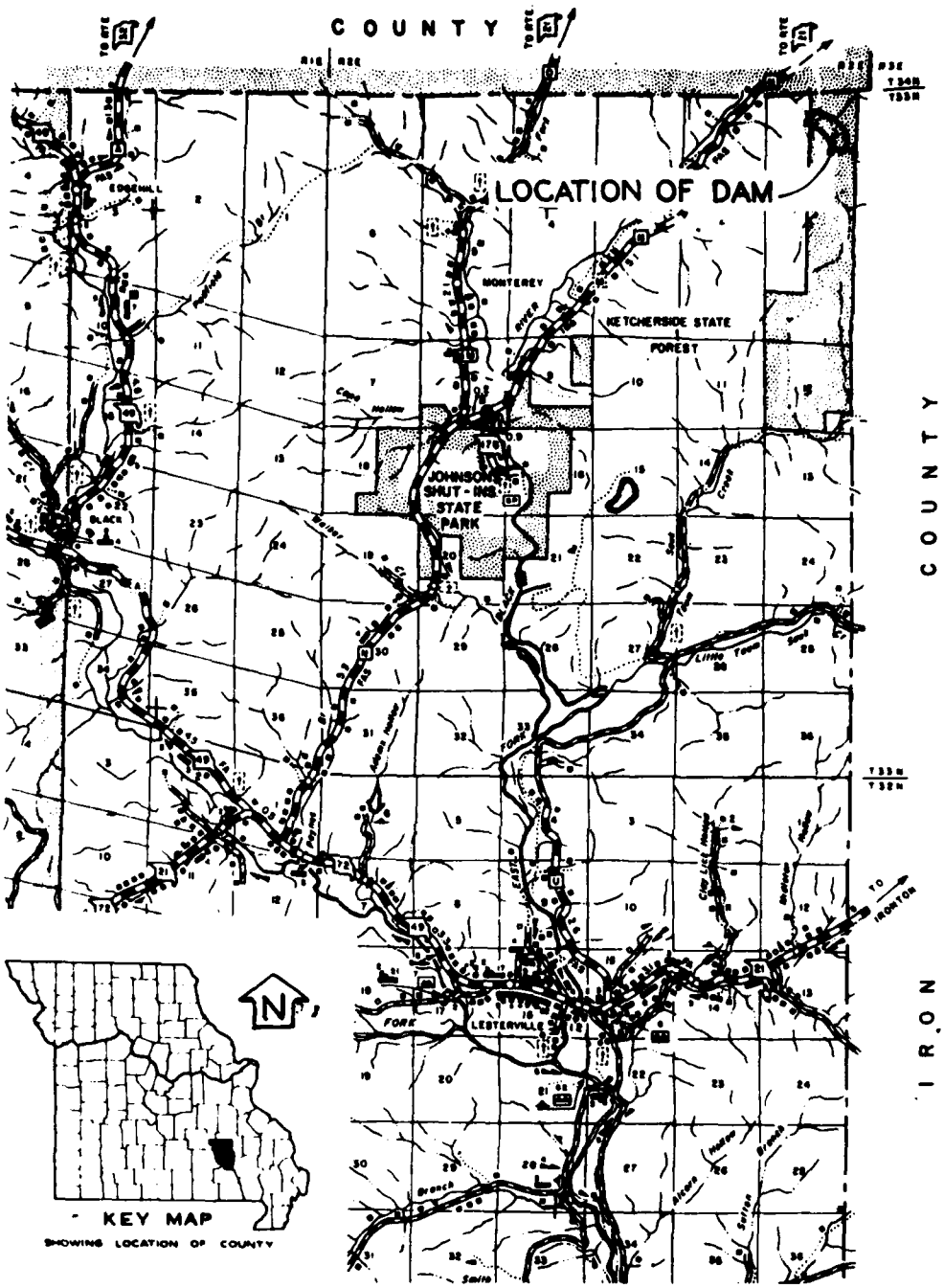
1. Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. The dam should be surveyed and an as-built set of plans and drawings should be completed.

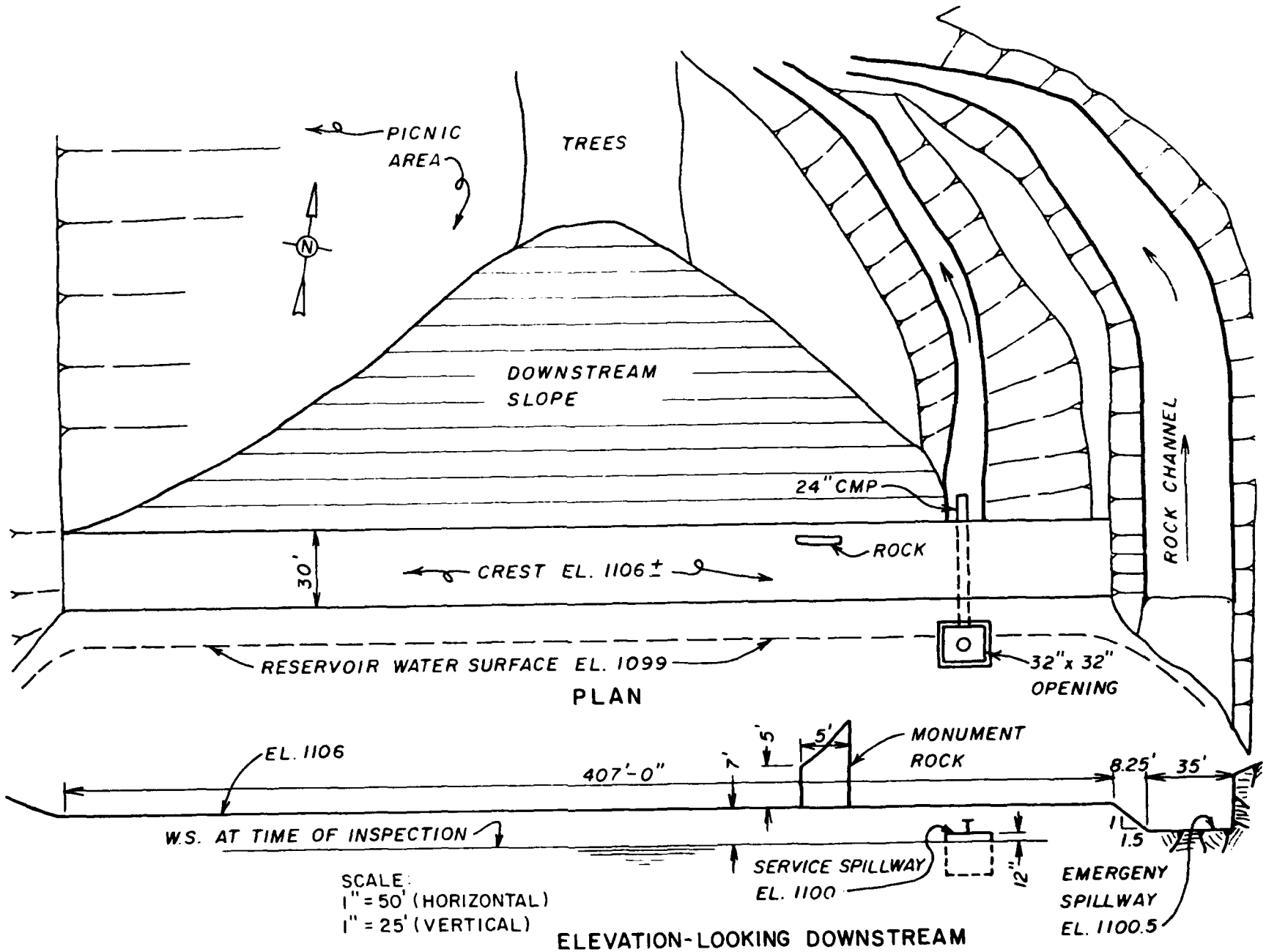
4. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

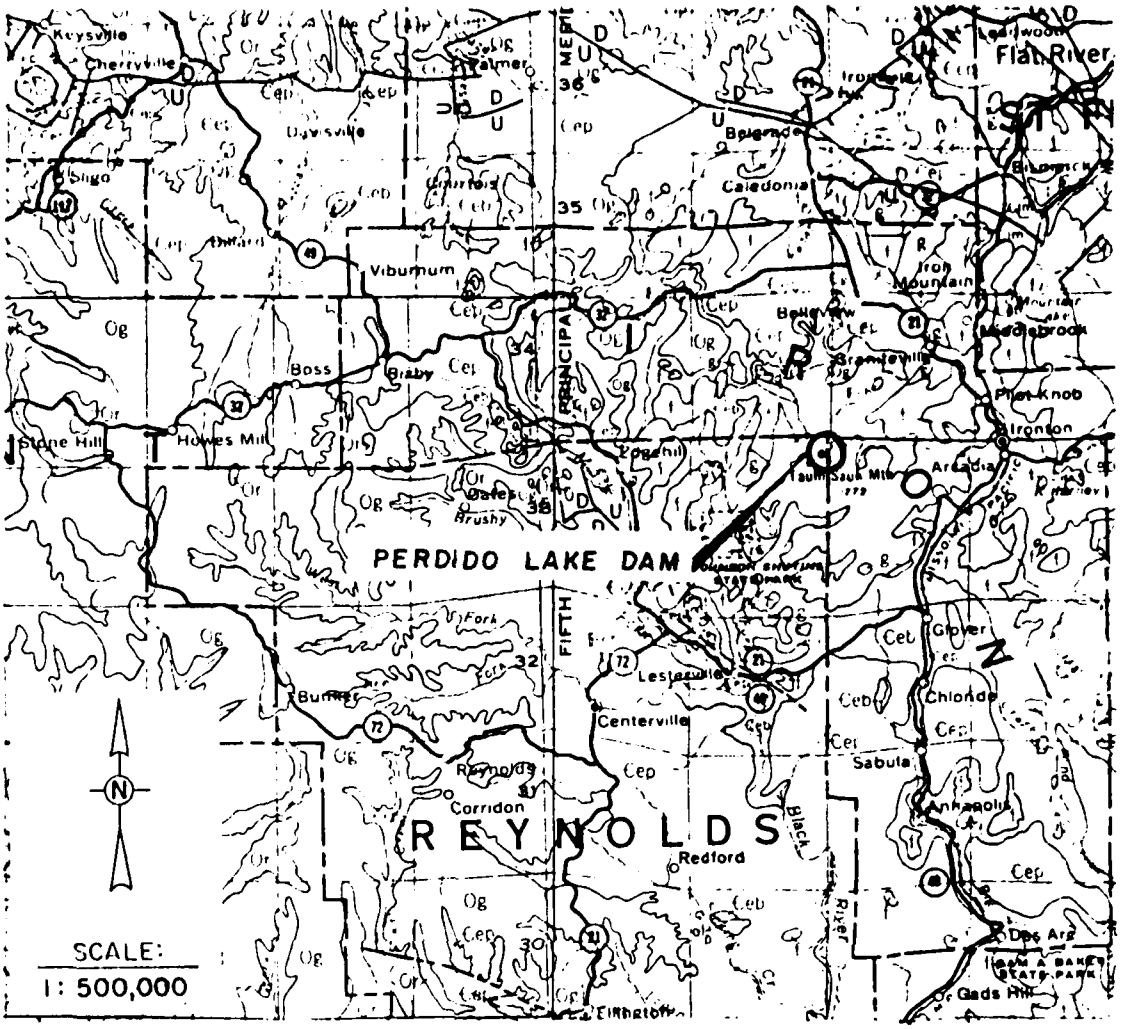
PLATES



LOCATION MAP
PERDIDO DAM
REYNOLDS COUNTY, MISSOURI

PERDIDO DAM
RELATIVE ELEVATIONS





Explanation

Ordovician System

O_r - sandstone, chert, dolomite.
O_g - cherty dolomite, with a basal sandstone

Cambrian System

ϵ_{ep} - dolomite and chert
ϵ_{eb} - dolomites, limestones, shale and sandstone.
ϵ_{lm} - sandstone: coarse grained to conglomeratic

Pre-Cambrian System

d - Diabace and basalt.
g - Granites.
f - Felsites.

Reference: Geologic Map of Missouri, 1961, Division of Geological Survey and Water Resources, State of Missouri.

General Geologic Map

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

PERDIDO LAKE DAM

Photo 1 - View along crest of dam taken at right abutment.

Photo 2 - View along upstream slope of embankment taken from spillway approach channel. Note intake structure for service spillway.

Photo 3 - Close-up of typical section of upstream slope of embankment.

Photo 4 - View of downstream slope of embankment taken from downstream of dam.

Photo 5 - Picture of downstream slope of embankment taken near right side of dam.

Photo 6 - Discharge end of corrugated metal pipe used for service spillway.

Photo 7 - Discharge channel for service spillway.

Photo 8 - Approach channel for emergency spillway. Note post for former fence across spillway.

Photo 9 - Picture of emergency spillway channel taken from upstream.

Photo 10 - Picture of downstream channel of emergency spillway taken from upstream.

Photo 11 - Picture of left bank of emergency spillway discharge channel. Note eroded bank in center of picture.

Photo 12 - Close-up of eroded left bank of emergency spillway discharge channel.

Photo 13 - Picture of small eroded channel at downstream end of emergency spillway discharge channel.

Photo 14 - View of downstream channel below dam. Note picnic tables.

Photo 1 - View along crest of dam taken at right abutment.

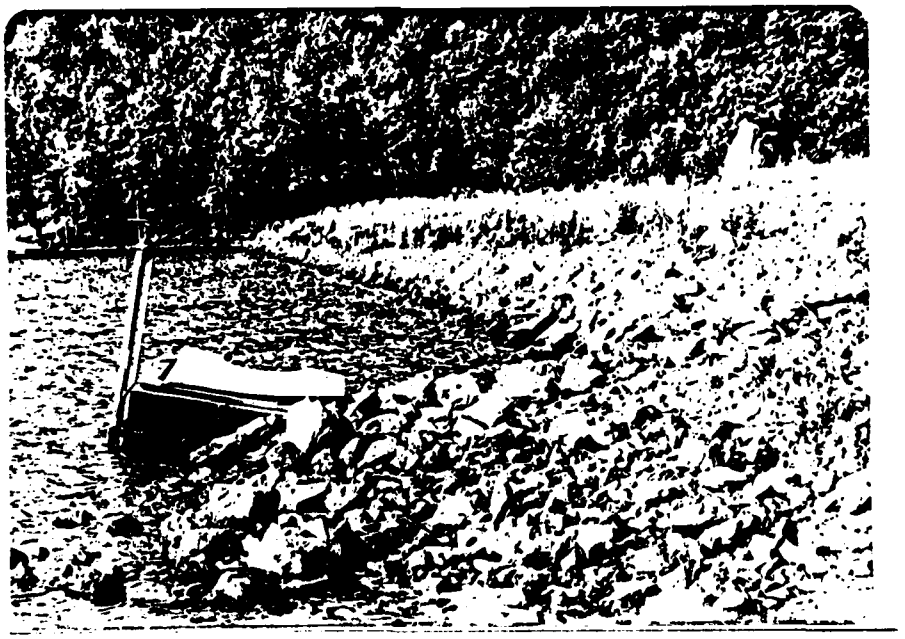


Photo 2 - View along upstream slope of embankment taken from spillway approach channel. Note intake structure for service spillway.

Photo 3 - Close-up of typical section of upstream slope of embankment.

Photo 4 - View of downstream slope of embankment taken from downstream of dam.

Photo 5 - Picture of downstream slope of embankment taken near right side of dam.

Photo 6 - Discharge end of corrugated metal pipe used for service spillway.

Photo 7 - Discharge channel for service spillway.

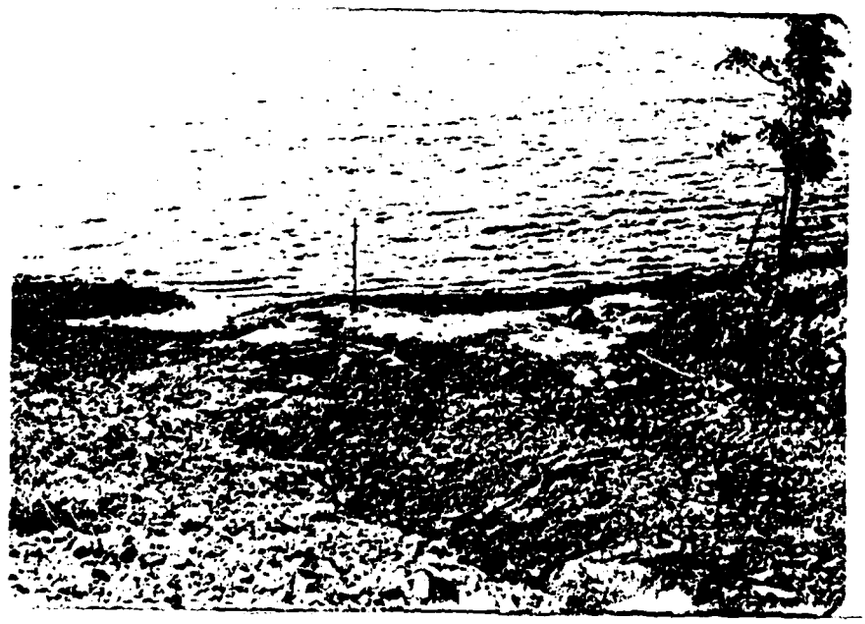


Photo 8 - Approach channel for emergency spillway. Note post for former fence across spillway.

Photo 9 - Picture of emergency spillway channel taken from upstream.

Photo 10 - Picture of downstream channel of emergency spillway taken from upstream.

Photo 11 - Picture of left bank of emergency spillway discharge channel. Note eroded bank in center of picture.

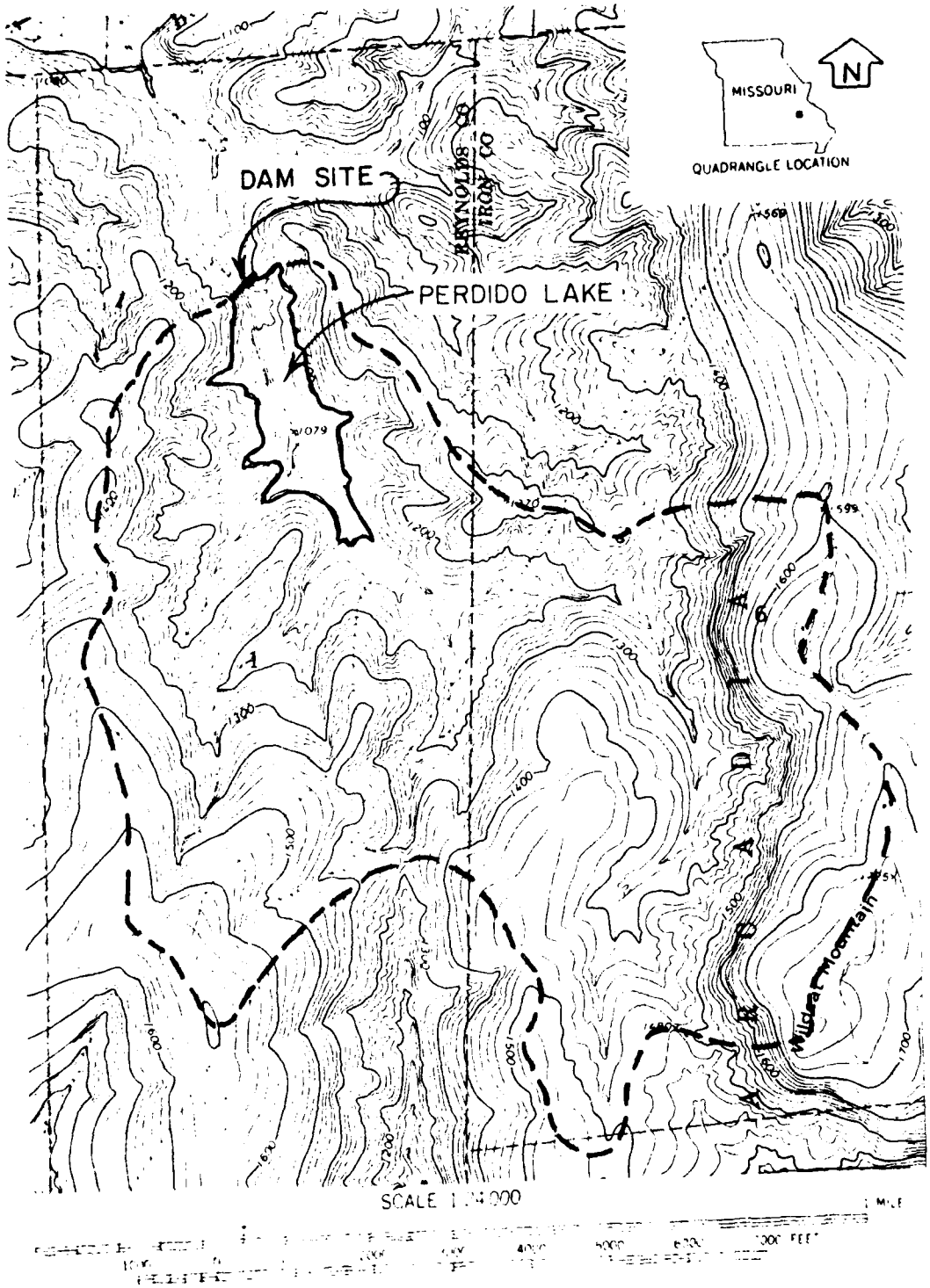
Photo 12 - Close-up of eroded left bank of emergency spillway discharge channel.

Photo 13 - Picture of small eroded channel at downstream end of emergency spillway discharge channel.

Photo 14 - View of downstream channel below dam. Note picnic tables.

APPENDIX B

HYDROLOGIC COMPUTATIONS



PERDIDO DAM
DRAINAGE BASIN

ECI-4 ENGINEERING CONSULTANTS, INC.

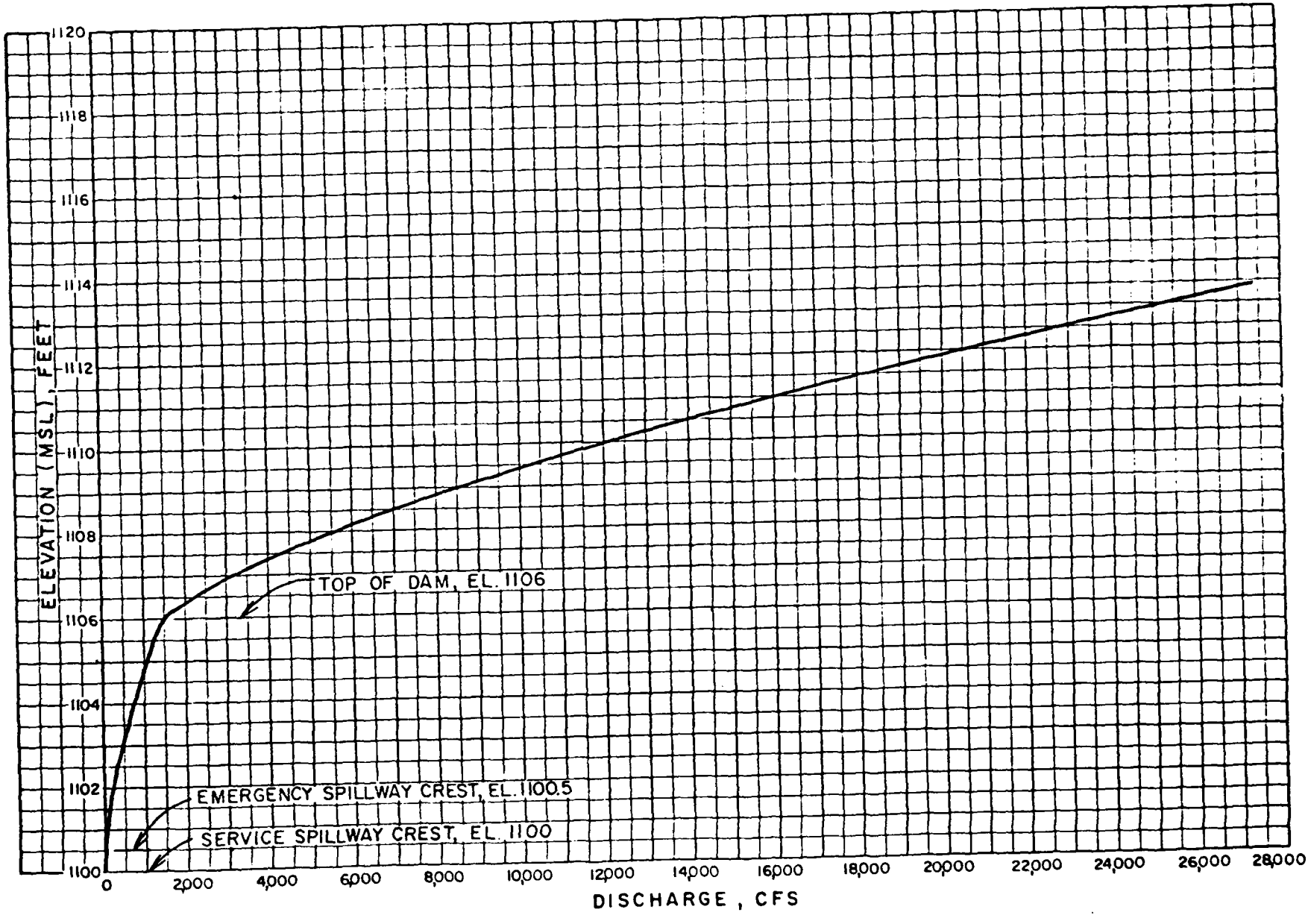
DAM SAFETY INSPECTION — MISSOURI
PERDIDO DAM
RESERVOIR AREA CAPACITY DATA

SHEET NO. 1 OF
JOB NO. 1223-001-1
BY KLB DATE 11-16-78

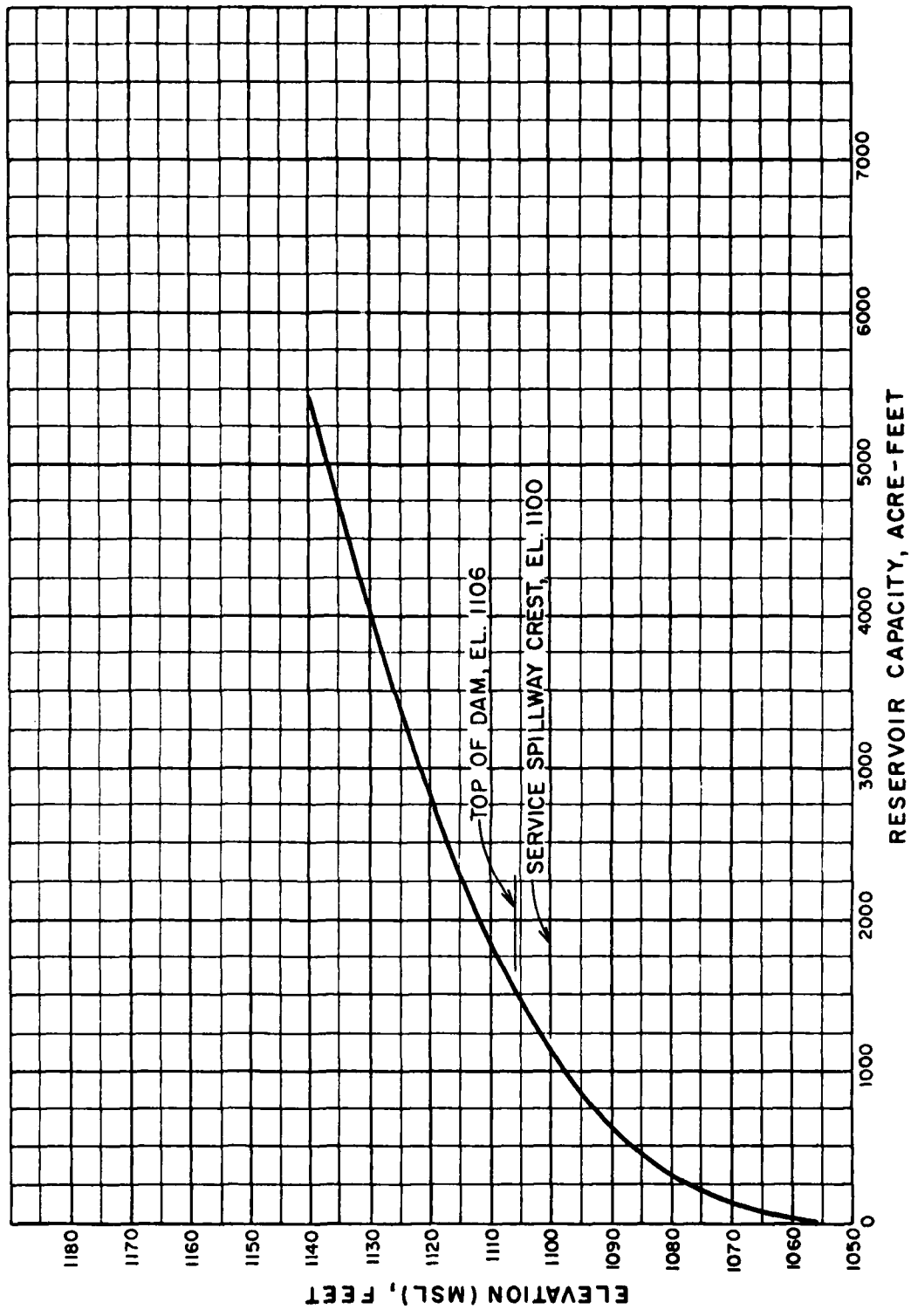
PERDIDO DAM

RESERVOIR AREA CAPACITY DATA.

ELEVATION (FT)	RESERVOIR SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
1056	0	—	0	
1060	5.30	7.1	7.1	AREA MEASURED ON U.S.G.S. MAP.
1080	24.24	295.4	302.5	AREA MEASURED ON U.S.G.S. MAP
1100	58.33	825.7	1128.2	ASSUMED SPILLWAY CREST ELEV. AREA MEASURED ON U.S.GS. MAP
1100.5	60.5	29.7	1157.9	EMERGENCY SPILLWAY ELEVATION
1106.0	72.4.	365.5	1523.4	TOP OF DAM ELEVATION
1120	106.81	1254.5	2777.9	AREA MEASURED ON U.S.G.S. MAP.
1140	162.81	2696.2	5474.1	AREA MEASURED ON U.S.G.S. MAP.



PERDIDO DAM
COMBINED SPILLWAYS & OVERTOP
RATING CURVE



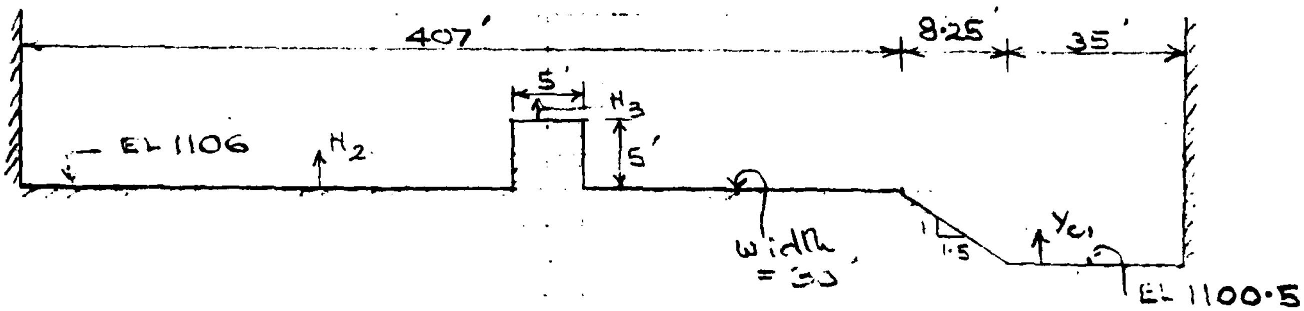
PERDIDO DAM
RESERVOIR CAPACITY CURVE

ENGINEERING CONSULTANTS, INC.

[illegible] INSPECTION / MISSOURI — SHEET NO. 1 OF

[illegible] DAM — JOB NO. 1223-001

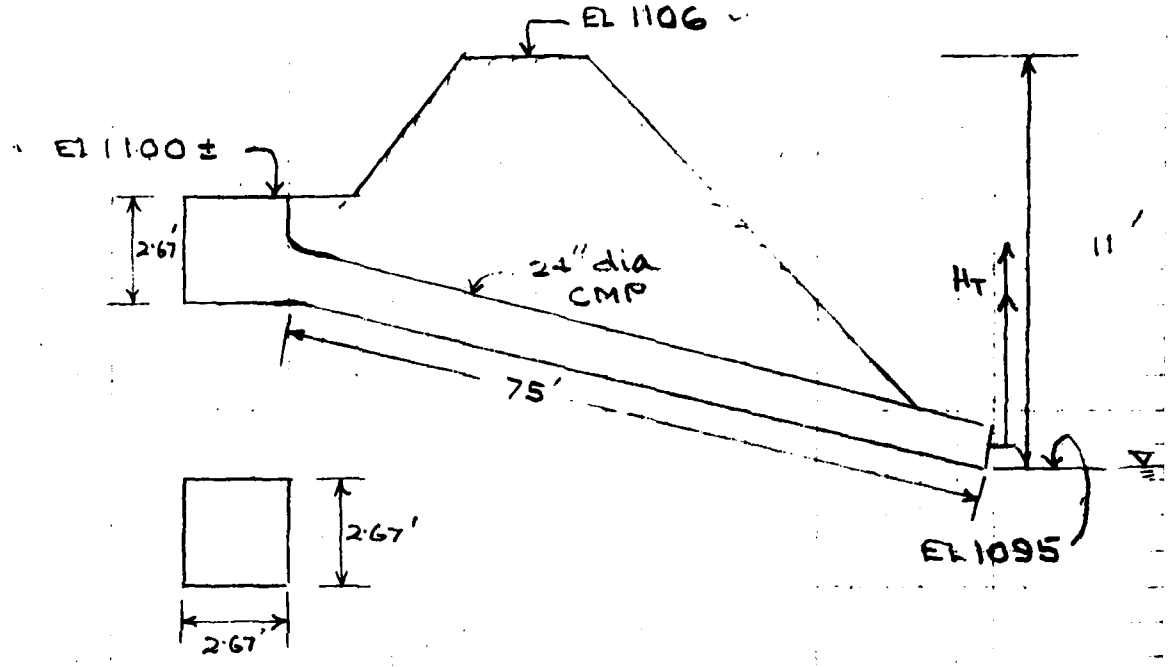
[illegible] SPILLWAY & OVERTOP DISCHARGE CAPACITY BY MAS — DATE 11/12/78



Y_{c1}	T_{c1}	A_{c1}	$V_{c1} = 5.67 \times \sqrt{A_{c1}/T_{c1}}$	$\frac{V_{c1}^2}{2g}$	$Q_1 = A_{c1}V_{c1}$	Upstream W.S. EL. $= 1100.5 + Y_{c1} + \frac{V_{c1}^2}{2g}$	H_2	C_2	L_2	$Q_2 = C_2 L_2 H_2^{1.5}$	H_3	C_3	L_3	$Q_3 = C_3 L_3 H_3^{1.5}$	$Q_1 + Q_2 + Q_3$
1	36.5	35.75	5.61	0.49	201	1101.99									201
2	38.0	73.00	7.86	0.96	574	1103.46									574
4	41.0	152.00	10.92	1.85	1660	1106.35	0.35	2.68	402	223					1883
5	42.5	193.75	12.11	2.28	2346	1107.78	1.78	2.63	402	2511					4857
5.5	43.25	215.19	12.65	2.48	2722	1108.48	2.48	2.63	402	4129					6851
7	43.25	267.69	14.11	3.09	3777	1110.59	4.59	2.63	402	10397					14174
9	43.25	377.69	15.84	3.90	5983	1113.40	7.40	2.63	402	21283	1.40	2.64	5	22	27288

SERVICE SPILLWAY DISCHARGE CAPACITY

PERDIDO DAM: SERVICE SPILLWAY DISCHARGE



Q when W.S. EL@1100.5

a) Weir flow:

$$Q = CLH^{3/2} = 3.01 \times 2.67 \times 4 \times .5^{1.5} = 11 \text{ cfs}$$

b) Pipe flow:

Assume $n = 0.024$, & $K_e = 0.5$

$$H_T = \left(1 + K_e + \frac{29n^2L}{R^{1.33}}\right)\frac{V^2}{2g}$$

$$= \left(1 + 0.5 + \frac{29 \times .024^2 \times 75}{0.5^{1.33}}\right)\frac{V^2}{2g}$$

$$= 4.65\frac{V^2}{2g}$$

$$V = \frac{1}{\sqrt{4.65}}\sqrt{2gH_T} = 0.46\sqrt{2gH_T}$$

$$\underline{Q = 0.46A\sqrt{2gH_T}}$$

$$Q = 0.46 \times \pi \times 1^2 \sqrt{64.4 (1100.5 - 1096)}$$

$$= 25 \text{ cfs} > Q_{weir}$$

Actual $\underline{Q = 11 \text{ cfs}}$

Q when W.S EL @ 1101.99

a) Weir flow

$$Q = 3.01 \times 2.67 \times 4 \times (1101.99 - 1100)^{1.5}$$

$$= 90 \text{ cfs}$$

b) Pipe flow:

$$Q = 0.46 \times \pi \times 1^2 \times \sqrt{64.4 (1101.99 - 1096)}$$

$$= 28 \text{ cfs} > Q_{weir}$$

Actual $\underline{Q = 28 \text{ cfs}}$

Upstream W.S. Elev.	H_T	$Q = 0.46 A \sqrt{2g H_T}$, $= 11.60 \sqrt{H_T}$
1101.99	5.99	28 cfs
1103.46	7.46	32 "
1106.35	10.35	37 "
1107.78	11.78	40 "
1108.48	12.48	41 "
1110.59	14.59	44 "
1113.40	17.40	48 "

DAM SAFETY INSPECTION / MISSOURI
PERDIDO DAM
~ SPILLWAYS' & OVERTOP DISCHARGE CAPACITY

SHEET NO. 4 OF
JOB NO. 1223-001
BY MAS DATE 11/14/78
CHK

Upstream W.S. Elev.	Discharge Through Service Spillway	Discharge Through Em Spillway & overtop of dam	Total discharge
1100.00	0	0	0
1100.5	11	0	11
1101.99	28	201	229
1103.46	32	574	606
1106.35	37	1883	1,920
1107.78	40	4857	4,897
1108.48	41	6851	6,892
1110.50	44	14174	14,218
1113.40	48	27288	27,336

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION- MISSOURI — SHEET NO. 1 OF ____

PERDIDO DAM — JOB NO. 1223-001-1

UNIT HYDROGRAPH PARAMETERS. — BY KLB DATE 11-6-78

1. DRAINAGE AREA = 1571 AC = 2.45 SQ. MI.

2. LENGTH OF STREAM $L = 5.9" \times 2000 / 5280 = 2.23$ MI

3. DIFFERENCE IN ELEVATION, ΔH

$\Delta H = 1550 - 1100 = 450$ FT

4. TIME OF CONCENTRATION, T_c

$$T_c = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385}$$

$T_c = 0.62$ HR

5. LAG TIME, $L_t = 0.6 \times T_c$

$L_t = 0.6 \times 0.62 = 0.37$ HR

6. RAINFALL UNIT DURATION, D

$D \leq \frac{L_t}{4} = \frac{0.37}{4} = 0.09$ HR

USE D = 5 MIN = 0.083 HR.

7. TIME TO PEAK, T_p

$T_p = \frac{D}{2} + 0.6 \times T_c$

$T_p = \frac{0.083}{2} + 0.6 \times 0.62$

$T_p = 0.41$ HR.

8 $q_p = \frac{484 A}{T_p} = \frac{484 \times 2.45}{0.41} = 2892$

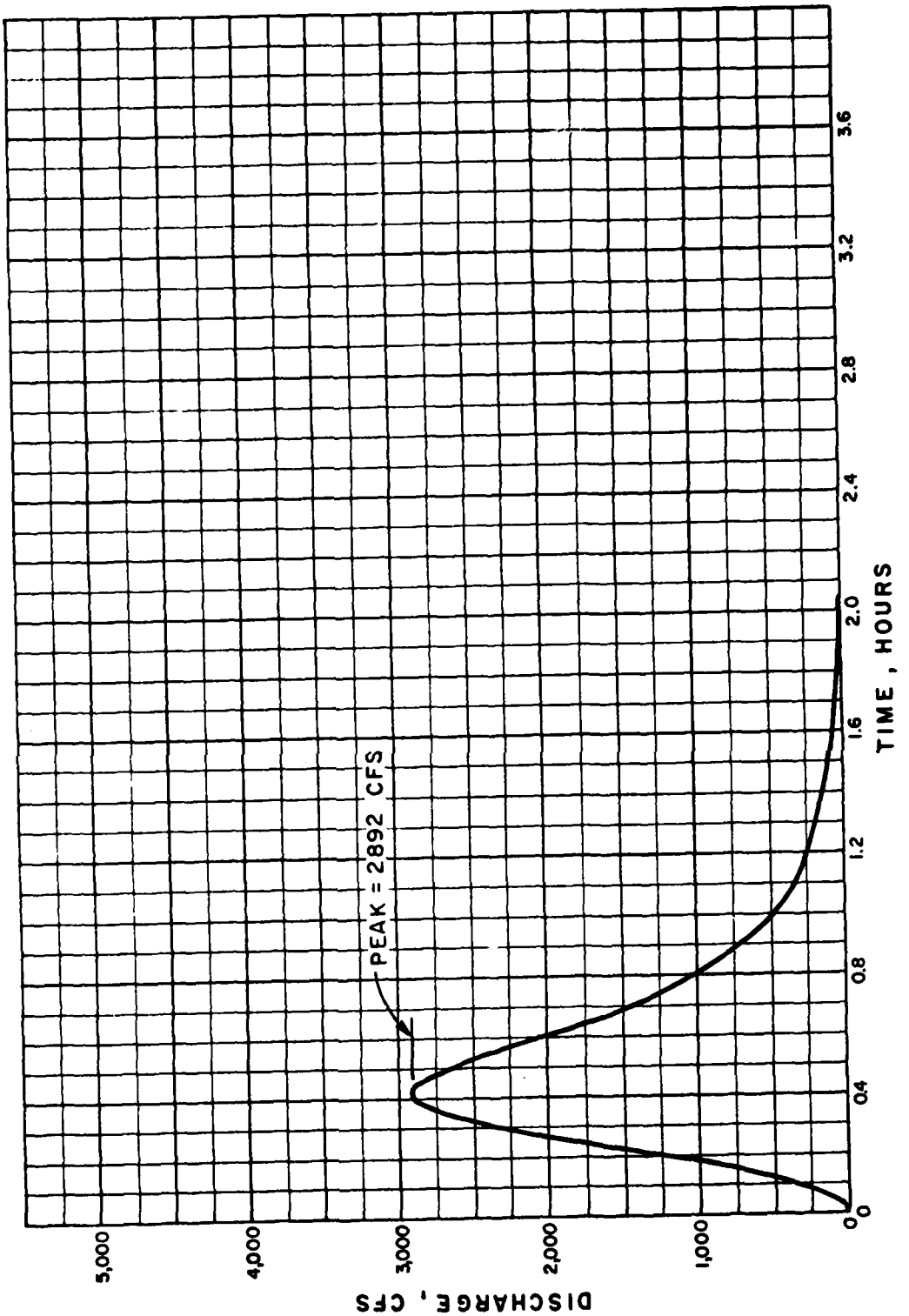
ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI
PERDIDO DAM
UNIT HYDROGRAPH DERIVATION

SHEET NO. 2 OF ...
JOB NO. 1223-001-1
BY MLB DATE 11-6-78

9) CURVILINEAR UNIT HYDROGRAPH

TIME T/Tp	DISCHARGE RATIO Q/Qp	UNIT HYDROGRAPH	
		TIME, T HR	DISCHARGE Q (CFS)
0.000	0.000	0.000	0.000
0.1	0.015	0.04	43.38
0.2	0.075	0.08	216.90
0.3	0.16	0.12	462.72
0.4	0.28	0.16	809.76
0.5	0.45	0.21	1301.40
0.6	0.60	0.25	1735.20
0.7	0.77	0.29	2226.84
0.8	0.89	0.33	2573.88
0.9	0.97	0.37	2805.60
1.0	1.00	0.41	2892.00
1.1	0.98	0.45	2834.16
1.2	0.92	0.49	2660.64
1.3	0.84	0.53	2429.28
1.4	0.75	0.57	2169.00
1.5	0.66	0.62	1908.72
1.6	0.56	0.66	1619.52
1.8	0.42	0.74	1214.64
2.0	0.32	0.82	925.44
2.2	0.24	0.90	694.08
2.4	0.18	0.98	520.56
2.6	0.13	1.07	375.96
2.8	0.098	1.15	283.42
3.0	0.075	1.23	216.90
3.5	0.036	1.44	104.11
4.0	0.018	1.64	52.06
4.5	0.009	1.85	26.03
5.0	0.004	2.05	11.57



PERDIDO DAM
5 MINUTE UNIT HYDROGRAPH

DETERMINATION OF PMS

1. Determine drainage area of the basin

   D.A. = 1571 acres = 2.45 sq. mi.

2. Determine PMP Index rainfall:

   Location of centroid of basin:

   Long. 90.77°; Lat.: 37.63°

   → PMP for 200 sq. mi. & 24 hrs duration

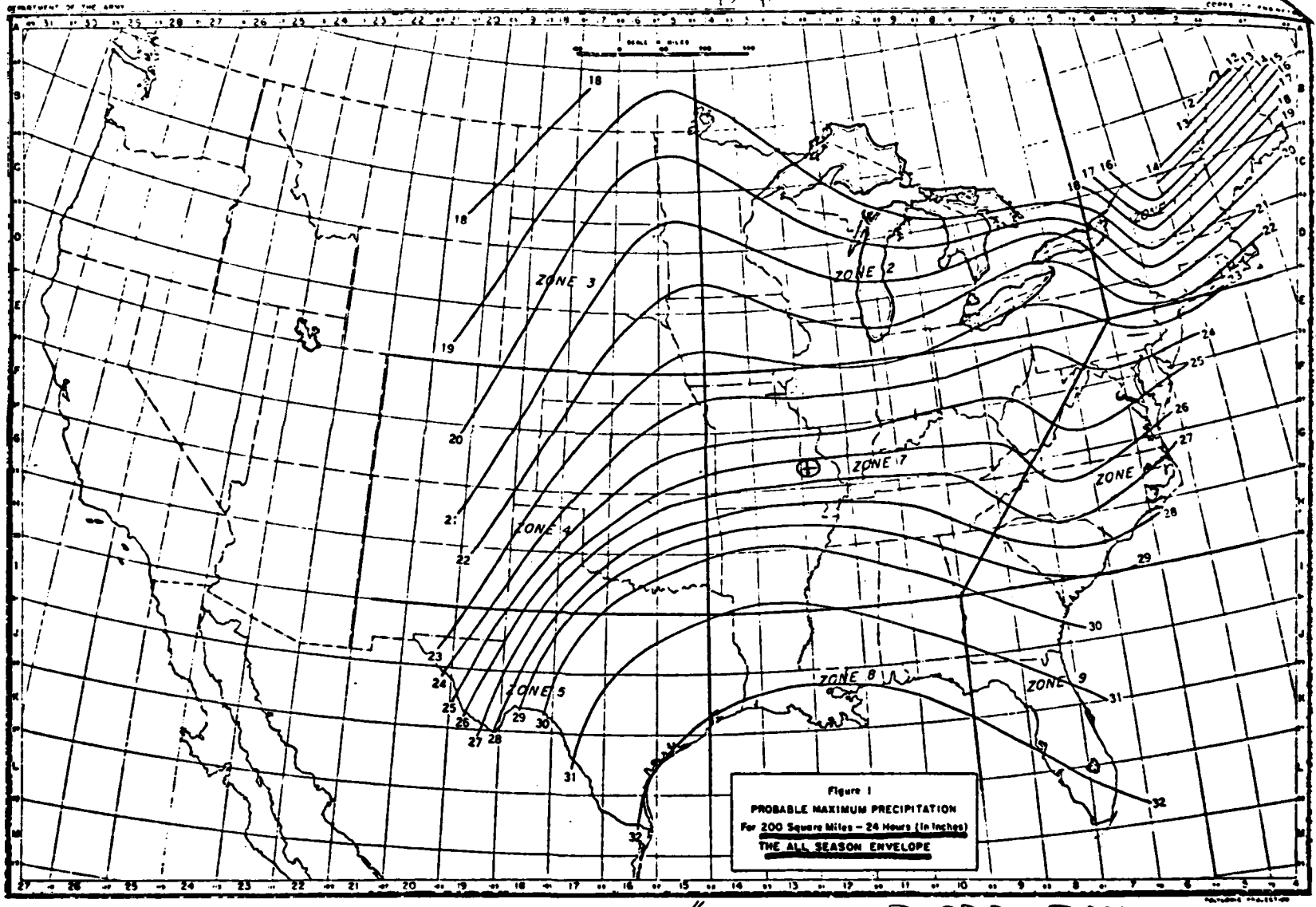
   = 26.4" (from Fig 1, HMR NO 33)

3. Determine basin rainfall in terms of percentage of PMP Index rainfall for various durations:

   Location: Long. 90.77°; Lat. 37.63°

   ⇒ Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of increment (Hrs.)
6	100	26.4	26.4	6
12	120	31.7	5.3	6
24	130	34.3	2.6	12



26·4"

PERRIDO DAM
DETERMINATION OF PMP

ECI 4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1
PERDIDO DAM JOB NO. 1223-001-1
100 YEAR FLOOD BY REGRESSION EQUATION BY KLB DATE 11-20-7

PERDIDO DAM

100 YEAR FLOOD BY REGRESSION EQUATION

REGRESSION EQUATION FOR 100 YEAR FLOOD FOR MISSOURI:

$$Q_{100} = 85.1\ A^{0.934\,A^{-0.02}}\ S^{0.576}$$

WHERE

A = DRAINAGE AREA IN SQ. MI.

S = MAIN CHANNEL SLOPE Ft/mi.
(AVG. SLOPE BETWEEN 0.1 L AND 0.85L
L, BEING LENGTH OF MAIN STREAM)

FOR PERDIDO DAM:

$A = 2.45$ SQ. MI.

$$S = \frac{1456 - 1127}{0.75 \times 2.23} = 196.71 \text{ Ft/Ft.}$$

$$Q_{100} = 85.1\ (2.45)^{0.934\,(2.45)^{-0.02}}\ (196.71)^{0.576}$$

4057 CFS

HEC1DB INPUT DATA

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION:  JULY 1978
 LAST MODIFICATION  23 AUG 78
**********
```

```
     1          A1   DAM SAFETY INSPECTION - MISSOURI
     2          A2   PERRIDO DAM
     3          A3   PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING
     4          B    300       0       5       0       0       0       0       0       0       0
     5          B1   5
     6          J    1       2       1
     7          J1   1.0     0.5
     8          K    0       19                                              1
     9          K1   INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT HYDROGRAPH
    10          M    1       -1      2.45            2.45    1.0
    11          P            26.4    100     120     130
    12          T                                                   0.85    0.07
    13          U    27
    14          U1   0.0     190     800     1440    2540    2892    2650    2140    1619    181
    15          U1   910     670     470     355     270     210     170     130     180     7
    16          U1   52      40      37      25      13      3       0.0
    17          X            0.      1
    18          K    1       19                      2               1
    19          K1   RIUTE HYDROGRAPH THROUGH PERRIDO DAM
    20          V                                1       1
    21          V1   1                                          -1100.          =1
    22          VQ   1100.0   1100.50 1101.99 1103.46 1104.88 1106.39 1107.35 1108.48 1110.99 1113.88
    23          VS   0.0     11      229     606     1500    1920    4897    6892    14218   27356
    24          SS   0.0     7.1     302.5   1128.2  1157.9  1523.4  2777.9  5474.1
    25          SE   1050    1060    1080    1100    1100.5  1106.0  1120    1140
    26          SS   1100.
    27          SD   1106.
    28          K    99
```

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  21 AUG 78
**********

RUN  DATE= 78/11/28.
     TIME= 13.45.11.
```

DAM SAFETY INSPECTION - MISSOURI
PERIOD DAM
PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNI

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
19	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	2.45	0.00	2.45	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.40	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.65	.07	0.00	0.00

GIVEN UNIT GRAPH, NUHGO= 27

0.	190.	800.	1640.	2580.	2892.	2650.	2140.	1619.	1214.
910.	670.	470.	355.	270.	210.	170.	130.	100.	78.
52.	40.	37.	25.	13.	3.	0.			

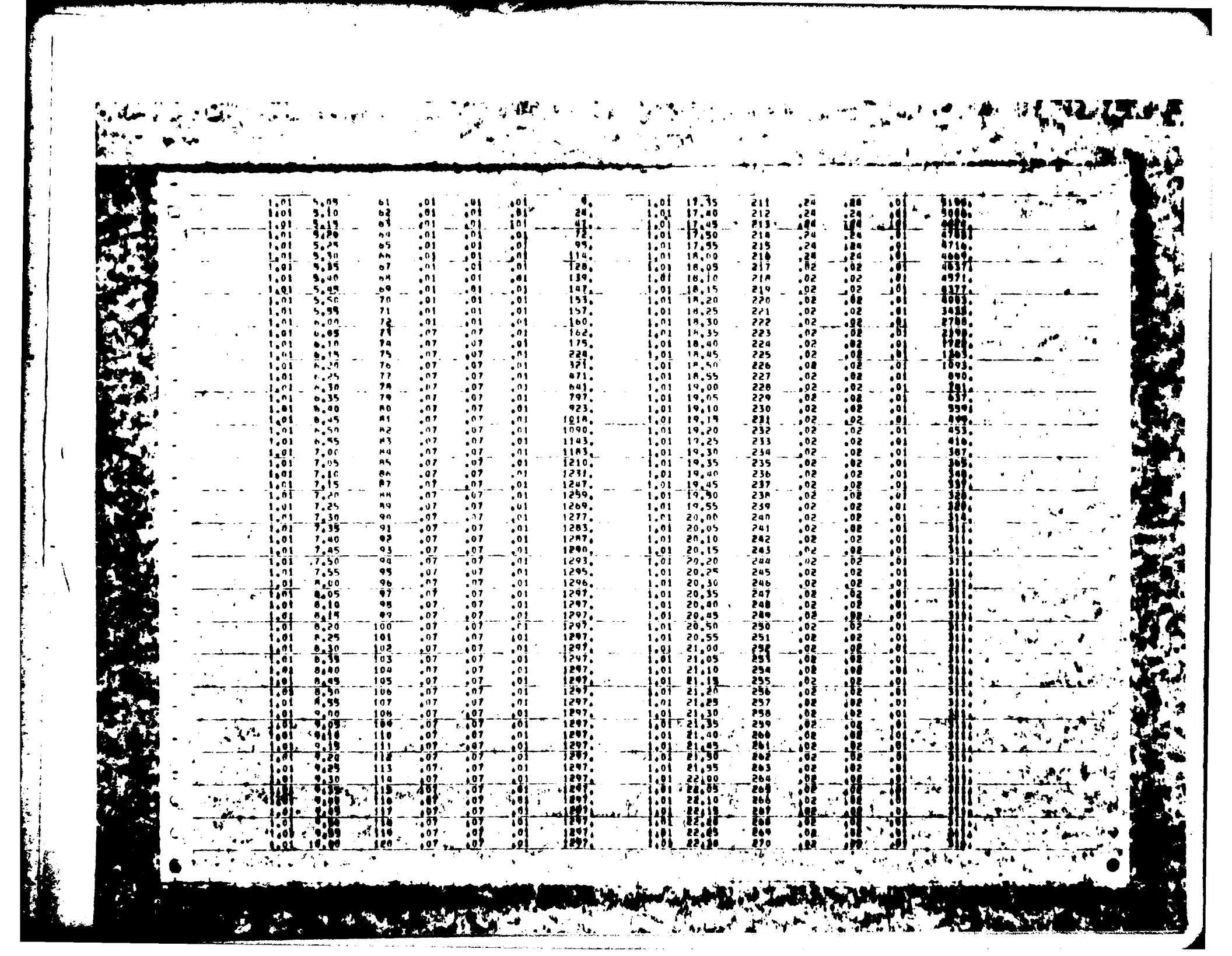
UNIT GRAPH TOTALS 19218. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q



1.01	10.05	121	.07	.07	.01	1297.	1.01	22.35	271	.02	.02	.01	311.
1.01	10.10	122	.07	.07	.01	1297.	1.01	22.40	272	.02	.02	.01	311.
1.01	10.15	123	.07	.07	.01	1297.	1.01	22.45	273	.02	.02	.01	311.
1.01	10.20	124	.07	.07	.01	1297.	1.01	22.50	274	.02	.02	.01	311.
1.01	10.25	125	.07	.07	.01	1297.	1.01	22.55	275	.02	.02	.01	311.
1.01	10.30	126	.07	.07	.01	1297.	1.01	23.00	276	.02	.02	.01	311.
1.01	10.35	127	.07	.07	.01	1297.	1.01	23.05	277	.02	.02	.01	311.
1.01	10.40	128	.07	.07	.01	1297.	1.01	23.10	278	.02	.02	.01	311.
1.01	10.45	129	.07	.07	.01	1297.	1.01	23.15	279	.02	.02	.01	311.
1.01	10.50	130	.07	.07	.01	1297.	1.01	23.20	280	.02	.02	.01	311.
1.01	10.55	131	.07	.07	.01	1297.	1.01	23.25	281	.02	.02	.01	311.
1.01	11.00	132	.07	.07	.01	1297.	1.01	23.30	282	.02	.02	.01	311.
1.01	11.05	133	.07	.07	.01	1297.	1.01	23.35	283	.02	.02	.01	311.
1.01	11.10	134	.07	.07	.01	1297.	1.01	23.40	284	.02	.02	.01	311.
1.01	11.15	135	.07	.07	.01	1297.	1.01	23.45	285	.02	.02	.01	311.
1.01	11.20	136	.07	.07	.01	1297.	1.01	23.50	286	.02	.02	.01	311.
1.01	11.25	137	.07	.07	.01	1297.	1.01	23.55	287	.02	.02	.01	311.
1.01	11.30	138	.07	.07	.01	1297.	1.02	0.00	288	.02	.02	.01	311.
1.01	11.35	139	.07	.07	.01	1297.	1.02	.05	289	0.00	0.00	0.00	311.
1.01	11.40	140	.07	.07	.01	1297.	1.02	.10	290	0.00	0.00	0.00	306.
1.01	11.45	141	.07	.07	.01	1297.	1.02	.15	291	0.00	0.00	0.00	295.
1.01	11.50	142	.07	.07	.01	1297.	1.02	.20	292	0.00	0.00	0.00	266.
1.01	11.55	143	.07	.07	.01	1297.	1.02	.25	293	0.00	0.00	0.00	227.
1.01	12.00	144	.07	.07	.01	1297.	1.02	.30	294	0.00	0.00	0.00	188.
1.01	12.05	145	.22	.21	.01	1297.	1.02	.35	295	0.00	0.00	0.00	150.
1.01	12.10	146	.22	.21	.01	1325.	1.02	.40	296	0.00	0.00	0.00	103.
1.01	12.15	147	.22	.21	.01	1442.	1.02	.45	297	0.00	0.00	0.00	77.
1.01	12.20	148	.22	.21	.01	1683.	1.02	.50	298	0.00	0.00	0.00	57.
1.01	12.25	149	.22	.21	.01	2055.	1.02	.55	299	0.00	0.00	0.00	42.
1.01	12.30	150	.22	.21	.01	2480.	1.02	1.00	300	0.00	0.00	0.00	38.

SUM 34.32 32.13 2.19 617348.
(872.)(816.)(56.)(17481.29)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	21151.	6807.	2144.	2058.	617331.
CMS	599.	193.	61.	58.	17481.
INCHES		25.84	32.55	32.55	32.55
MM		656.45	826.88	826.88	826.88
AC-FT		3375.	4252.	4252.	4252.
THOUS CU M		4163.	5244.	5244.	5244.

HYDROGRAPH AT STA 19 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9.	24.	47.	72.	95.	114.	128.	139.	147.	153.
157.	160.	162.	175.	224.	321.	471.	641.	797.	[illegible]
1018.	1090.	1143.	1183.	1210.	1231.	1247.	1259.	1269.	1277.
1283.	1287.	1290.	1293.	1295.	1296.	1297.	1297.	1297.	1297.
1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.
1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.
1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.
1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.	1297.
1297.	1297.	1297.	1297.	1297.	1325.	1442.	1683.	2055.	2480.

2868.	3188.	3420.	3596.	3731.	3839.	3928.	3999.	4036.	4137.
4273.	4420.	4551.	4670.	4779.	4879.	4970.	5053.	5098.	5224.
4989.	5107.	5208.	5297.	5378.	5452.	5521.	5583.	5698.	5808.
6132.	6131.	6083.	6045.	6095.	6419.	7263.	9809.	12472.	16381.
19772.	21151.	20428.	18483.	16162.	13988.	12096.	10913.	02691	8342.
7757.	7300.	6960.	6697.	6493.	6318.	6126.	5929.	5696.	5436.
5195.	5006.	4874.	4783.	4716.	4669.	4637.	4571.	4377.	4083.
3433.	2788.	2198.	1722.	1363.	1093.	890.	741.	637.	559.
499.	453.	418.	387.	365.	348.	337.	328.	320.	316.
311.	311.	311.	311.	311.	311.	311.	311.	311.	311.
311.	311.	311.	311.	311.	311.	311.	311.	311.	311.
311.	311.	311.	311.	311.	311.	311.	311.	311.	311.
311.	311.	311.	311.	311.	311.	311.	311.	311.	311.
311.	311.	311.	311.	311.	311.	311.	311.	311.	308.
299.	268.	227.	180.	138.	103.	77.	57.	42.	32.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	21151.	6807.	2144.	2058.	617331.
CMS	599.	193.	61.	58.	17481.
INCHES		25.88	32.55	32.55	32.55
MM		658.45	826.88	826.88	826.88
AC-FT		3375.	4252.	4252.	4252.
THOUS CU M		4163.	5244.	5244.	5244.

HYDROGRAPH AT STA 19 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
5.	12.	21.	36.	48.	57.	64.	69.	73.	76.
78.	80.	81.	88.	112.	161.	235.	321.	399.	462.
509.	545.	572.	591.	605.	616.	623.	630.	635.	638.
641.	644.	645.	646.	647.	648.	649.	649.	649.	649.
649.	649.	649.	649.	649.	649.	649.	649.	649.	649.
649.	649.	649.	649.	649.	649.	649.	649.	649.	649.
649.	649.	649.	649.	649.	649.	649.	649.	649.	649.
649.	649.	649.	649.	649.	649.	649.	649.	649.	649.
649.	649.	649.	649.	649.	663.	721.	841.	1020.	1240.
1434.	1591.	1710.	1799.	1866.	1915.	1949.	1979.	2017.	2068.
2137.	2210.	2275.	2328.	2368.	2397.	2420.	2437.	2448.	2462.
2499.	2553.	2641.	2739.	2829.	2901.	2950.	2997.	3027.	3050.
3066.	3065.	3042.	3023.	3048.	3209.	3631.	4605.	6236.	8191.
9886.	10575.	10213.	9282.	8081.	6992.	6048.	5257.	4634.	8196.
3879.	3650.	3483.	3349.	3247.	3159.	3063.	2964.	2868.	2717.
2598.	2503.	2437.	2391.	2358.	2335.	2318.	2286.	2140.	2001.
1716.	1394.	1099.	861.	681.	547.	445.	371.	319.	280.
250.	227.	208.	198.	185.	174.	168.	164.	160.	157.
156.	155.	155.	155.	155.	155.	155.	155.	155.	155.
155.	155.	155.	155.	155.	155.	155.	155.	155.	155.
155.	155.	155.	155.	155.	155.	155.	155.	155.	155.
155.	155.	155.	155.	155.	155.	155.	155.	155.	155.
155.	155.	155.	155.	155.	155.	155.	155.	155.	155.
147.	134.	118.	90.	69.	51.	38.	29.	21.	16.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10575.	3403.	1072.	1029.	308665.

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

AND

DAM SAFETY ANALYSIS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

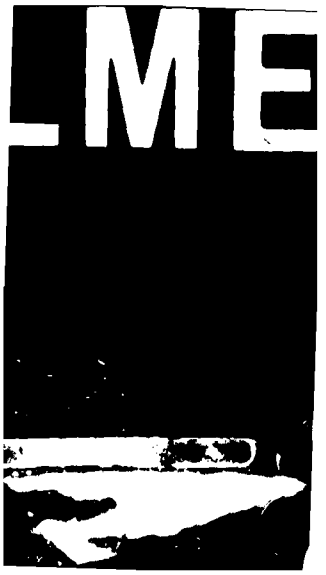
OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS	
				RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	10	2.45 (6.35)	1	21151. (598.92)	10575. (299.46)
ROUTED TO	10	2.45 (6.35)	1	17189. (486.75)	7280. (206.19)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1100.00	1100.00	1106.00
STORAGE	1128.	1128.	1523.
OUTFLOW	0.	0.	1900.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1110.96	4.96	1968.	17189.	6.50	16.25	0.00
.50	1104.59	2.59	1796.	7280.	4.50	16.33	0.00


LME